The Chiton Fauna of the Revillagigedo Archipelago, Mexico

BY

ANTONIO J. FERREIRA[1]

Research Associate, California Academy of Sciences, Golden Gate Park, San Francisco, California 94118, U.S.A.

(2 Plates; 10 Text figures)

The Revillagigedo Archipelago comprises the three islands of San Benedicto (19°18′N; 110°49′W), Socorro (18°45′N; 111°00′W) and Clarion (18°22′N; 114°45′W), and the nearby rocks of Partida and Alijos (Figures 1, 2, 3, 4). Volcanic in nature, the Revillagigedos stand isolated in the Pacific some 400km south of the tip of Baja California, 650km west of the Mexican mainland, 1000km north of Clipperton island, and over 5000km east of the Hawaiian islands. Scientific expeditions to the Revillagigedos have been relatively few and concerned mostly with the marine vertebrates, terrestrial biology and geology (Jordan & McGregor, 1899; Snodgrass & Heller, 1905; Hanna, 1926; Ricker, 1959; Bryan, 1964; Richards, 1966; Chan, 1974). Thus, the marine invertebrate fauna of Revillagigedos, the mollusks in general, and the chitons in particular have remained poorly known. Information on the chiton fauna of the Revillagigedos has been limited to Pilsbry's (1898: 51) brief report on 3 species of chitons collected by R. C. McGregor at Socorro. Strong & Hanna's (1930) list of 61 marine mollusks from Socorro and Clarion did not include a single chiton species.

This paper reports on data obtained in two collecting trips to the Revillagigedos aboard the R/V *Baja Explorador.* With a group of biologists led by Dan Gotshall, California Department of Fish and Game, intertidal exploration and SCUBA-diving at San Benedicto and Socorro (3-8 November 1979, collecting station numbers AJF 488-510) and Clarion (26-30 November 1981, AJF 640-648) produced a reasonably satisfactory first sampling of the chiton fauna of the Revillagigedos. The observations have since been supplemented with data and material available at the California Academy of Sciences (CAS), Natural History Museum of Los Angeles County (LACM), National Oceanic and Atmospheric Administration (NOAA), Academy of Natural Sciences of Philadelphia (ANSP), United States National Museum of Natural History (USNM) British Museum (Natural History) (BMNH), and in the private collection of Antonio J. Ferreira (AJF station numbers on file at CAS).

[1] For reprints and correspondence: 2060 Clarmar Way, San Jose, California 95128, U.S.A.

Eight species of chitons are here recognized in the Revillagigedo Archipelago, two new to science:

Lepidochitona keepiana Berry, 1948
Ischnochiton muscarius (Reeve, 1847)
Ischnochiton rugulatus (Sowerby, 1832)
Stenoplax corrugata (Carpenter *in* Pilsbry, 1892)
Lepidozona clarionensis Ferreira, spec. nov.
Lepidozona rothi Ferreira, spec. nov.
Chaetopleura scabricula (Sowerby, 1832)
Chiton articulatus (Sowerby, 1832)

SYSTEMATIC TREATMENT

POLYPLACOPHORA Gray, 1821

Neoloricata Bergenhayn, 1955

Ischnochitonina Bergenhayn, 1930

Lepidochitonidae Iredale, 1914

Lepidochitona Gray, 1821

Type-species: *Chiton marginatus* Pennant, 1777 [= *Chiton cinereus* Linnaeus, 1767], by M.

Lepidochitona keepiana Berry, 1948
(Figures *5*, 6)

Lepidochitona keepiana Berry, 1948: 13-15—McLean, 1969: 61; fig. 34.3 (reprinted, 1978)—Burghardt & Burghardt, 1969: 19; plt. 2, figs. 24-25—Abbott, 1974: 397—Ferreira, 1982: 107-108; figs. 28-33

[?] *Lepidochitona* sp., Smith, 1963: 148

"Lepidochitona dentiens (Gould)" Berry, 1922: 410, 415, 438-439; tbl. 1; plt. 1, figs. 7-9 (fossil) [not *Lepidochitona dentiens* (Gould, 1846), *fide* Berry, 1948: 15]

"Ischnochiton (Trachydermon) dentiens (Gould)" Pilsbry, 1892: 73-74; plt. 8, figs. 61-65; 1894: 65; plt. 15, fig. 26 [not *Lepidochitona dentiens* (Gould, 1846), *fide* Berry, 1948: 15]

Type Material and Type Locality:

Lepidochitona keepiana Berry, 1948: Holotype (S. S. Berry private colln., Redlands, California, Cat. no. 11992); para-

Figure 1

Location of the Revillagigedo Archipelago, Mexico

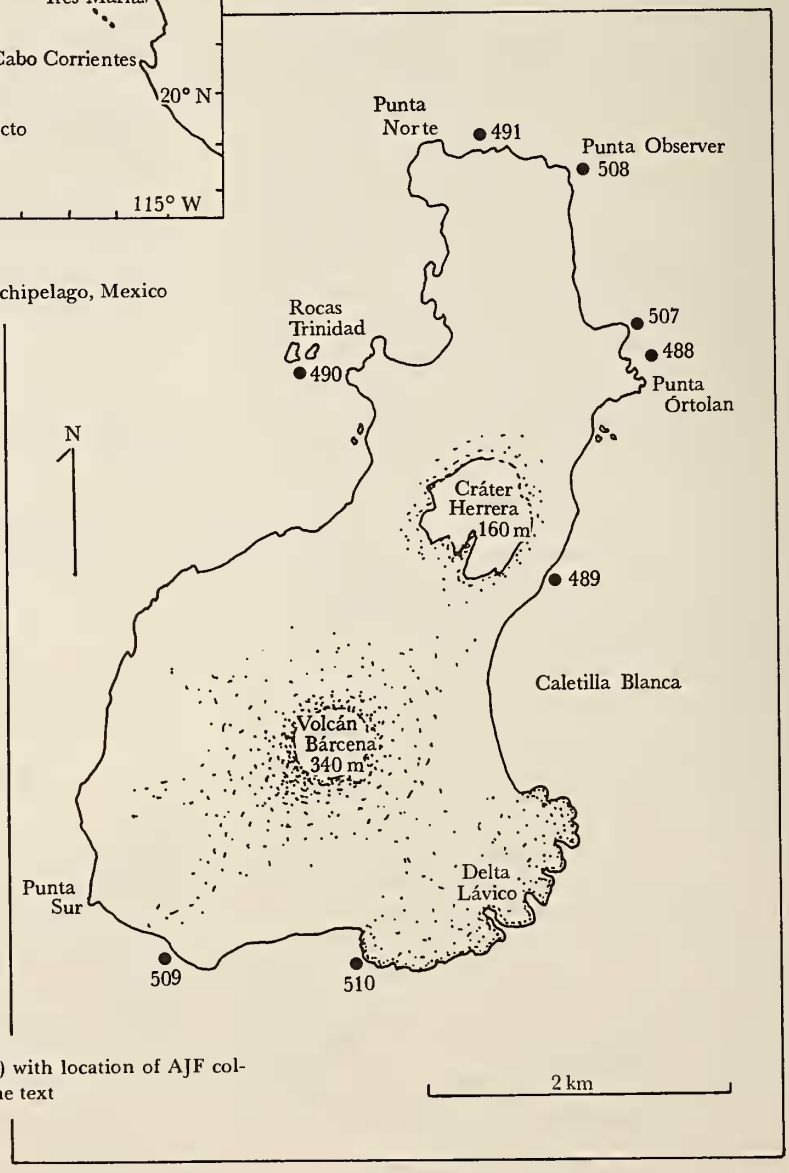

Figure 2

San Benedicto Island (19′N; 118°49′W) with location of AJF collecting station numbers mentioned in the text

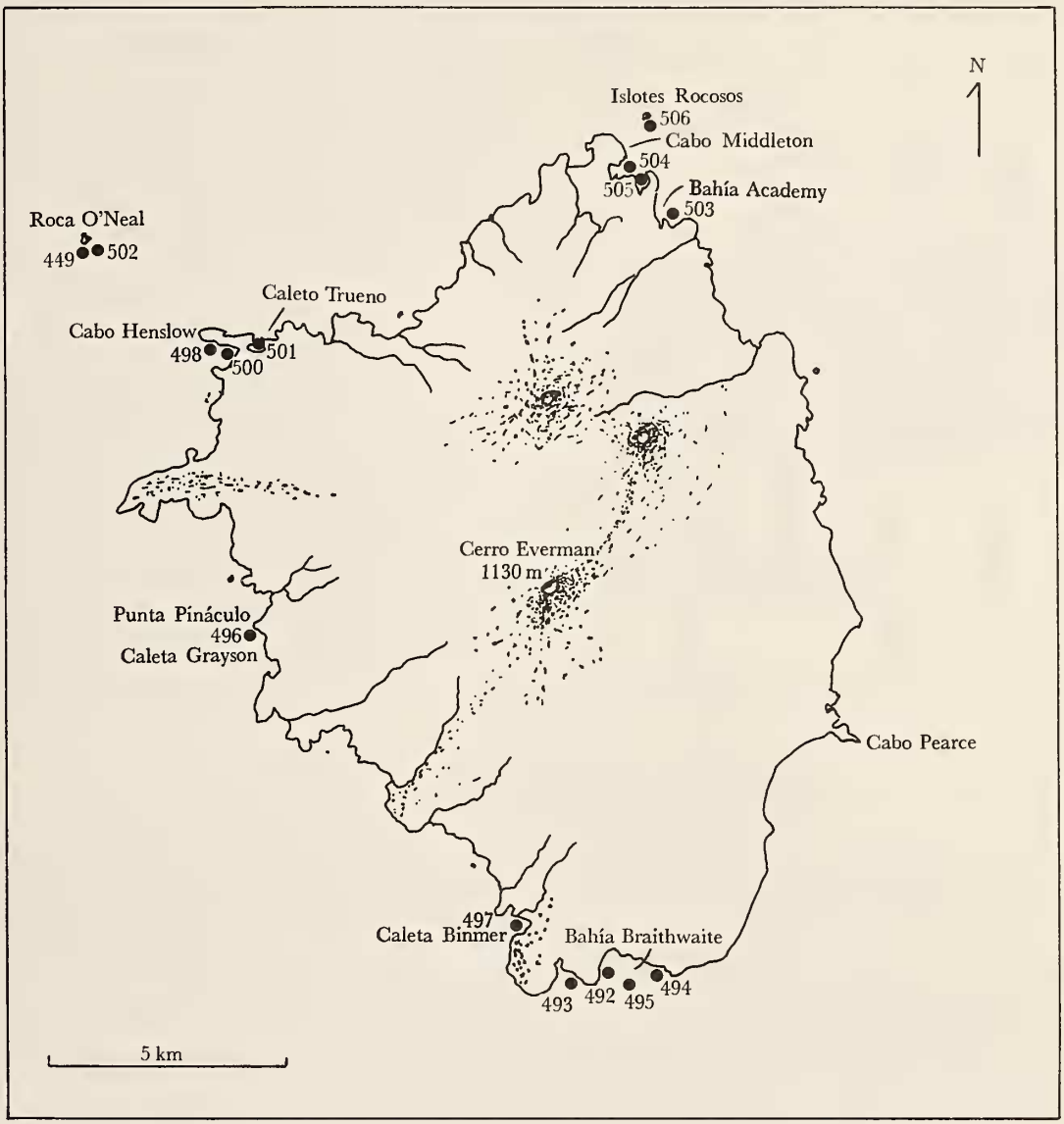

Figure 3

Socorro Island (18°45′ N; 111°00′ W) with location of AJF collecting station numbers mentioned in the text

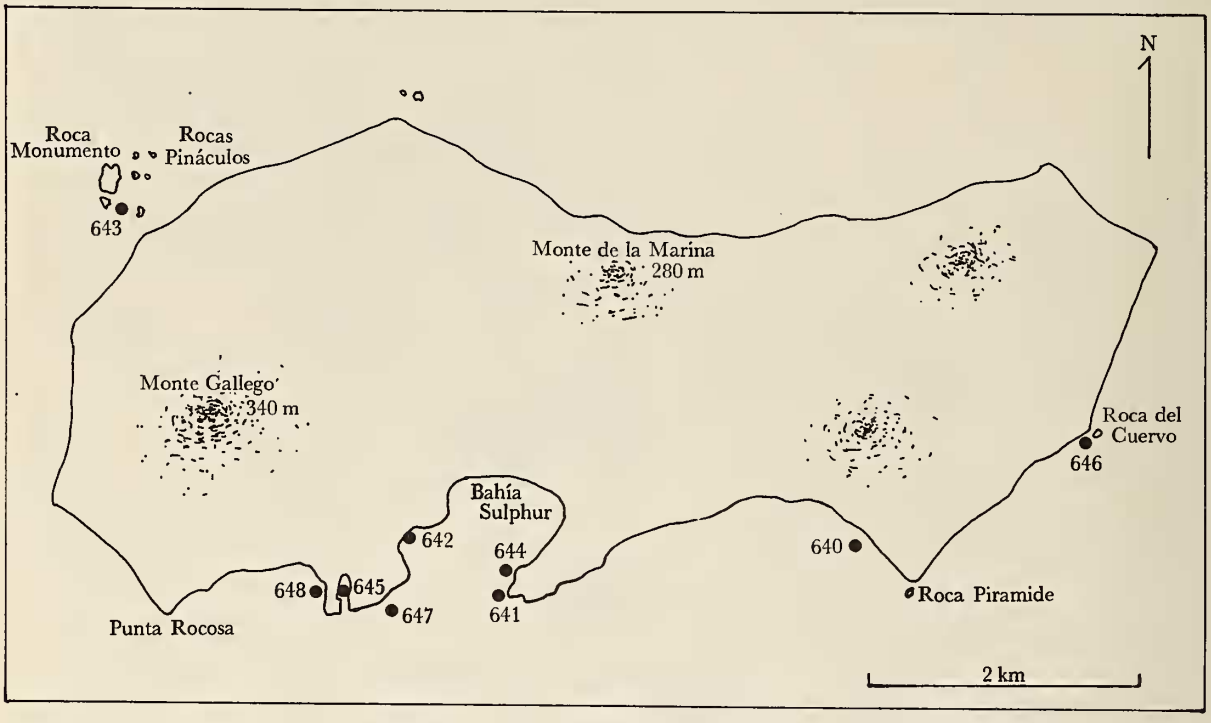

Figure 4

Clarion Island (18°22′N; 114°44′W) with location of AJF collecting station numbers mentioned in the text

types (S. S. Berry colln., Cat. no. 3978; SDNH T.S.18; USNM; BMNH; A. G. Smith colln. [now at CAS]; E. P. Chace colln.) *fide* Berry (1948); locality, Newport Bay, Orange County, California [33°37′N; 117°56′W]

Material Examined: SOCORRO: (ANSP 72499), 3 specimens, *leg.* R. C. McGregor [cited in Pilsbry, 1898: 51].

Description: Pilsbry (1898) reported the species at Socorro Island under the name of *dentiens* Gould, 1846, as "Rather small, black with indistinct dirty yellowish speckling and the usual sutural dots. Gills ambient, 15 on the right, 13 on the left side." (p. 51). The extant material (ANSP 72499) is accompanied by a museum label which reads, in part "T. dentiens Gld. / Socorro Island / R. C. McGregor ! off W. Mexico"; it consists of 3 specimens, dry, two intact but curled, one reduced only to the disarticulated valves. Large intact specimen, estimated length, 10mm, width (including girdle), 7.2mm. All specimens dark grayish green, with some vaguely defined lighter spots at posterior edge of valves i and ii. Carinate, slightly beaked valves with straight side slopes; curved outline. Tegmental surface shagreened, with very minute granules better defined in central areas where they tend to align themselves in longitudinal rows (Figure 5); sculptureless otherwise. Lateral areas hardly defined to obsolete, indicated only by slightly noticeable change in direction of tegmental granules. Mucro well defined, central to slightly anterior; postmucro concave. Disarticulated specimen's articulamentum light blue; valve i, 1.6mm long, 4.3mm wide; valve viii 4.0mm wide. On valve viii, sinus 0.8mm wide; rectangular sutural laminae, 1.7mm wide; sinus/sutural laminae, 0.46. Insertion teeth sharp, relatively regular, directed outward on viii; slits, 11-1-10, followed by slit rays defined by a line of minute orifices; at anterior edge of articulamentum of intermediate valves another row of orifices arranged as a second, spurious slit-ray. Eaves moderately spongy. Holobranchial. Girdle's upper surface dark greenish gray with sandy appearance, covered with minute scales, averaging 70 μm long, 38 μm wide, with a marginal fringe of longitudinally striated spicules, 140 μm long, 25 μm thick; undersurface with imbricated, transparent, spiculoid scales about 50 $\times$ 12 μm.

Although the specimens differ slightly from mainland specimens (see Ferreira, 1982), their identification as *Lepidochitona keepiana* is unequivocal.

Distribution: The known geographical range of *Lepidochitona keepiana* extends from Otters' Point, Monterey Bay, California (36°38′N; 121°55′W) to Rancho Socorro, Baja California, Mexico (30°20′N; 115°45′W). Berry's (1948) report of the species at San Ignatio Lagoon, Baja California, Mexico (26°42′N) has not been corroborated (Ferreira, 1982). Pilsbry's (1898) cited specimens (ANSP 72499) would place the species at Socorro Island, Revillagigedos, Mexico (18°45′N; 110°58′W).

Bathymetric range of mainland specimens, 0-10m.

Remarks: The presence of *Lepidochitona keepiana* at the Revillagigedos, if confirmed, constitutes an extraordinary eight degrees of southward range extension, and an adaptation to radically different thermal conditions. The verified geographical range of *L. keepiana* along the California to Baja California coast (Ferreira, 1982) corresponds to mean surface water temperatures between 12°C and 20°C. This fact makes the presence of *L. keepiana* at Socorro an apparent anomaly, since the habitual temperature range for *L. keepiana* falls outside the 21-28°C range of mean water surface temperatures at the Revillagigedos (Robinson, 1973; NOAA charts of monthly mean values of sea surface temperature) (Figure 6).

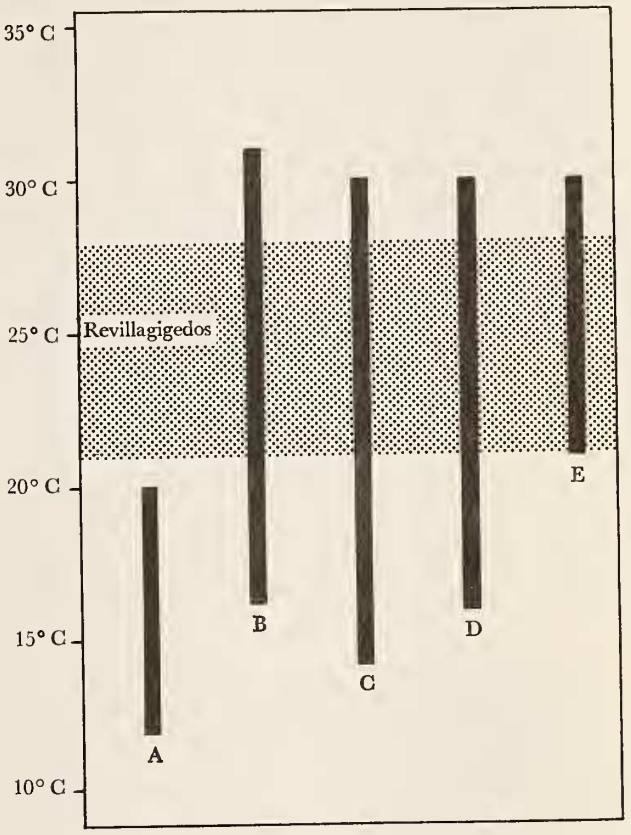

Figure 6

Range of mean water surface temperatures at the Revillagigedos versus range of water surface temperatures at the mainland for chiton species assumed common to both areas. Water temperature data from Robinson (1973) and NOAA charts. Chiton species: A = *Lepidochitona keepiana;* B = *Ischnochiton muscarius;* C = *Ischnochiton rugulatus;* D = *Chaetopleura scabricula;* E = *Chiton articulatus*

Ischnochitonidae Dall, 1889

Ischnochiton Gray, 1847a

Type species: *Chiton textilis* Gray, 1828, by SD (Gray, 1847b). The re-definition of the genus proposed by Kaas (1979: 856) is here adopted, and the name *Simplischnochiton* Van Belle, 1974, suppressed as a synonym.

Ischnochiton muscarius (Reeve, 1847)
(Figures 6, 7, 8)

Chiton muscarius Reeve, 1847: sp. & fig. 164; plt. 24
Ischnochiton muscarius (Reeve). Keen, 1958: 521, Amphineura, fig. 16 (with syn. *Lepidopleurus macandreae* Carpenter)
Radsiella muscaria (Reeve). Thorpe *in* Keen, 1971: 869, Polyplacophora, fig. 17 (with syn. *L. macandreae* Carpenter)
Lepidopleurus macandreae Carpenter, 1857c: 196-197, 500 (as *macandrei* on p. 196-197)—Brann, 1966: 45; plt. 20, fig. 255—Keen, 1968: 433-434; plt. 59, fig. 93

Type Material and Type Locality:

Chiton muscarius Reeve, 1847: Types unascertained; locality not stated
Lepidopleurus macandreae Carpenter, 1857: Holotype, Carpenter collection Tablet 904 (BMNH); locality, Mazatlan, Sinaloa, Mexico (23°13′N; 106°25′W)

Material examined: SOCORRO: 13 specimens, Caleta Binmer, intertidal zone (AJF 497) (Figures 7, 8).

Description: The specimens, preserved dry and flat, are grayish-brown, speckled with tawny brown and cream; 10 to 19.5mm long; width/length average 0.56. Carinate; valves posterior edge straight, not beaked; mucro central to slightly anterior; postmucro straight to slightly concave. Tegmental surface microgranular; central areas sculptureless; lateral areas with microgranules V-shaped in the center, defining 5-8 tenuous radial riblets; anterior valve and postmucro area of posterior valve with sculpture similar to that of lateral areas defining some 40-50 radial riblets. Girdle's upper surface with imbricated, elongate, strongly convex scales, about 200μm long, very finely striated.

The specimens agree in every respect with specimens of *Ischnochiton muscarius* from the mainland.

Distribution: *Ischnochiton muscarius* ranges from Venado Id., Guaymas, Sonora, Mexico (27°58′N; 111°07′W) (LACM 73-6) to La Ventosa, Salina Cruz, Oaxaca, Mexico (16°10′N; 95°12′W) (AJF Colln., *leg.* Nancy J. & A. J. Ferreira, December 1971), in the intertidal and low subtidal zones, 0-7m.

Remarks: Largest mainland specimen of *Ischnochiton muscarius* examined, 30.5mm long (AJF 302, Puerto Angel, Oaxaca, Mexico).

Ischnochiton rugulatus (Sowerby, 1832)
(Figures 6, *9, 10, 11, 12, 13*)

Chiton rugulatus Sowerby (1st) *in* Broderip & Sowerby, 1832: 58—Sowerby (1st & 2nd), 1840: 5; sp. no. 62, figs. 42, 143, 144—Reeve, 1847: plt. 19, fig. 118
Chiton catenulatus Sowerby (1st) *in* Broderip & Sowerby, 1832: 104—Sowerby (1st & 2nd), 1840: 5, sp. no. 61, fig. 145—Reeve, 1847: plt. 20, fig. 130
Chiton petaloides Gould, 1846: 144; 1852: 328, plt. 28, fig. 435 [reprinted, 1862: 6]—Smith, 1977: 231-232
Radsiella petaloides (Gould). Thorpe *in* Keen, 1971: 869, Polyplacophora, fig. 19 (with syn. *I. mariposa* Dall and *S. histrio* Berry).
Ischnochiton (Rhodoplax) petaloides (Gould). Smith & Ferreira, 1977: 85; fig. 5
Ischnochiton mariposa Dall, 1919: 505-507—Smith, 1977: 227-228
Stenoplax mariposa (Dall). Keen, 1958: 528, Amphineura, fig. 46 (with syn. *S. histrio* Berry)
Stenoplax histrio Berry, 1945: 493-495; figs. 10-18

Type Material and Type Locality:

Chiton rugulatus Sowerby, 1832: **Lectotype** (BMNH 198028) and **paralectotypes** (BMNH 198029; BMNH 198030; BMNH 198031) designated herein; locality, "ad oras Americae Centralis (Puerto Portrero and Inner Lobos Island)" here restricted to Isla Lobos de Tierra [= Inner Lobos Island], Peru (6°27′S; 80°52′W)
Chiton catenulatus Sowerby, 1832: **Lectotype** (BMNH 198032) and **paralectotypes** (BMNH 198033) designated herein; locality, "ad oras Peruviae (Inner Lobos Island)"
Chiton petaloides Gould, 1846: Holotype (USNM 12922); locality, "Sandwich Ids."
Ischnochiton mariposa Dall, 1919: Syntypes (USNM 58865); locality, "Gulf of California, W. J. Fisher"
Stenoplax histrio Berry, 1945: Holotype (CAS 029671 [formerly CAS 8040], and paratypes (S. S. Berry Collection Cat. No. 7116; "others to be deposited in the collections of the National Museum of Mexico, United States National Museum, and San Diego Museum of Natural History"); locality, "El Gallo, Mulege, Baja California," Gulf of California, Mexico

Material Examined: SOCORRO: 1 specimen, Caleta Binmer, 0-1m (AJF 497); 5 specimens, Caleta Trueno, 0-1m (AJF 501); 1 specimen, Islotes Rocosos, 13m (AJF 506, *leg.* Gwen Cornfield)

Description: The 7 specimens of *Ischnochiton rugulatus* collected at Socorro vary in color from green to tan mottled but showing characteristic bright blue dots; 6.8 to 10mm in length. Girdle scales oval, flattish, about 150μm long, and some 30 very fine striations. No essential differences were found between specimens from Socorro (Figures *9, 10*) and specimens from the mainland or Hawaii.

Distribution: *Ischnochiton rugulatus* has a unique distribution. It is the only eastern Pacific chiton present in Hawaii (holotype of *Chiton petaloides*, Gould, 1846; AJF colln., Oahu Id., *leg.* Kay Gudnason, 1974, H. Bertsch, 1977, R. & Anty Schock, 1977; Bishop Museum, Maui Id., *leg.* C. H. Edmondson, 18-19 June 1931). On the Pacific side of Baja California, Mexico, it has been collected from as far north as Malarrimo Point (27°44′N; 114°43′W) (LACM-AHF 2022-51) to Cabo San Lucas, throughout the Gulf of California up to Puerto Peñasco, Sonora (31°20′N; 113°33′W) (AJF colln., *leg.* A. J. Ferreira, December 1971, H. Bertsch, December 1975), in many localities along the coast of Mexico (AJF colln.), Costa Rica (LACM 72-52), Nicaragua (AJF 133), Panama (LACM B-23), Ecuador (LACM 70-9), south to Isla Lobos de Afuera, Peru (6°57′S; 80°42′W) (LACM 74-6). The species is also present in the Galápagos Islands (CAS 019943; CAS 020073; CAS 020074; CAS 020075; CAS 020076; see Smith & Ferreira, 1977).

Explanation of Figures *5* and *7* to *13*

Figure *5: Lepidochitona keepiana* Berry, 1948. Specimen ca. 10mm long (ANSP 72499). Tegmental surface of intermediate valves
Figure *7: Ischnochiton muscarius* (Reeve, 1847). Specimen 15mm long (AJF 497, Socorro Id., Revillagigedos, Mexico)
Figure *8:* Same as in Fig. *7.* Close-up of intermediate valves
Figure *9: Ischnochiton rugulatus* (Sowerby, 1832). Specimen 10mm long (AJF 501, Socorro Id., Revillagigedos, Mexico)
Figure *10:* Same as in Fig. *9.* Close-up of intermediate valves
Figure *11: Chiton rugulatus* Sowerby, 1832. **Lectotype** (BMNH 190828)
Figure *12:* Same as in Fig. *11.* Close-up of intermediate valves
Figure *13: Ischnochiton rugulatus* (Sowerby, 1832): *Chiton catenulatus* Sowerby, 1832. **Lectotype** (BMNH 190832)

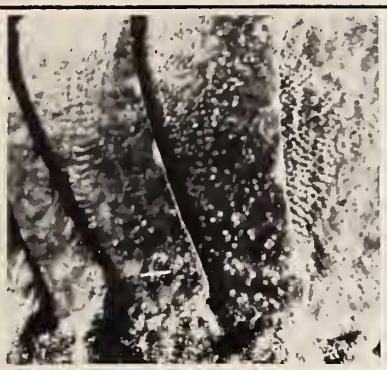

Figure 5

Figure 7

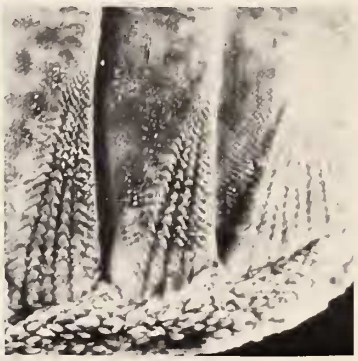

Figure 8

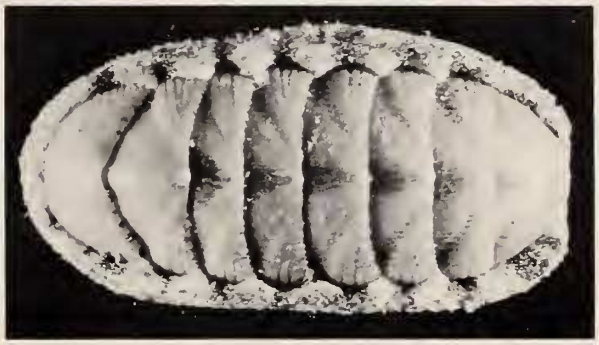

Figure 9

Figure 10

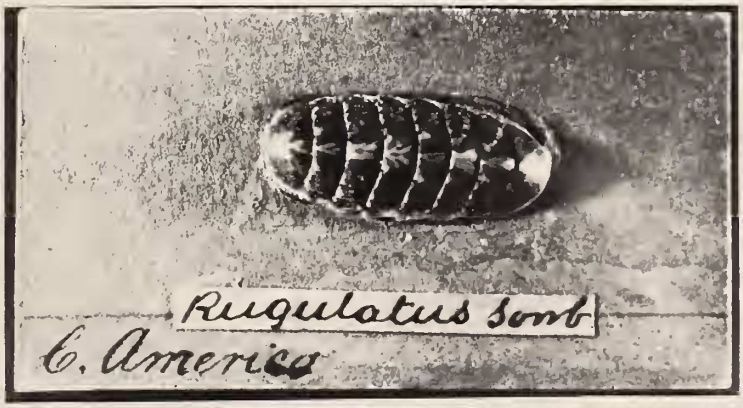

Figure 11

Figure 12

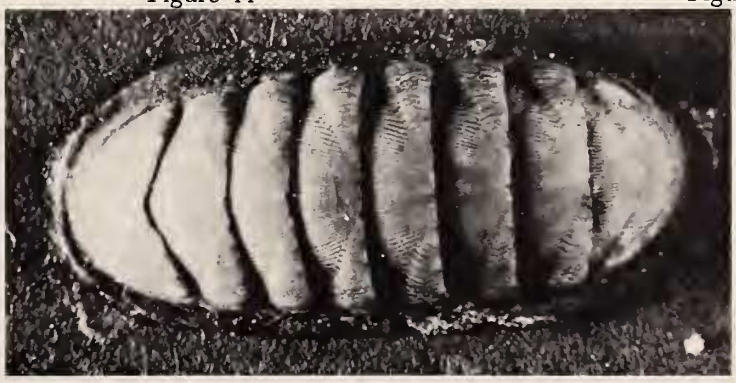

Figure 13

Bathymetric range, intertidal to shallow subtidal zones, 0 to 20m (AJF 128, off San Diego Id., Gulf of California, Mexico).

Remarks: The type material of *Chiton rugulatus* Sowerby, 1832, consists of 4 lots from the H. Cuming collection. The figured specimen (Sowerby, 1840, fig. 143; Reeve, 1847, plt. 19, fig. 118) is here designated **lectotype** (BMNH 198028). It is accompanied by a blue museum label which reads, in part "Chiton rugulatus Sowerby / Syntype / Central America." The specimen, dry, flat, well preserved, glued to a wooden board (Figures *11*, *12*) is 19.5mm long and 8.5mm wide; dark green with creamy blotches and electric-blue dots parajugally on all valves; concentric rugosities or wrinkles on valve i, postmucro area of valve viii, and lateral areas of intermediate valves; the tegmental wrinkles tend to continue onto the pleural areas as vague riblets; jugum mostly smooth with occasional minute pits; valve viii inflated with central, prominent mucro; girdle scales small, striated. The specimens in the other three lots are here designated **paralectotypes**. They include a lot (BMNH 198019) of 4 dry specimens glued to a wooden tabloid, one partly disarticulated, 17mm, 15.5mm, and 10.5mm long; one specimen black with white jugal stripe, three others mottled, showing characteristic electric-blue dots. Accompanying label reads, in part, "Syntypes / Central America / Figured in Conch. Illust. fig. 42 = black & white spec.? and fig. 144 = spec. measuring 14mm ?" A second lot (BMNH 198030), contains a single specimen, also labelled "Syntype / Central America," 10.5mm long. A third lot (BMNH 198031), labelled, in part, "? Syntypes (labelled rugulatus var.) / Central America" consists of two specimens, 12.1mm and 11.2mm long, uniformly brown color. In every respect the specimens agree with Sowerby's (1832) description and illustration (1840), and with the current concept of *Ischnochiton petaloides* (Gould, 1846).

The type material of *Chiton catenulatus* Sowerby, 1832, consists of a lot of 4 specimens, dry flat, glued on a wooden board on which is written "Ischnochiton catenulatus / Inner Lobos I. Sow." A blue museum label reads, in part, "Syntypes / Inner Lobos I. / H. Cuming colln. / 4 specs." The specimens are all uniform light cream-brown color; they measure 18.4mm, 14.6mm, 15.3mm, and 16.0mm in length. In shape, tegmental sculpture, and girdle characteristics, they correspond in every respect to Sowerby's (1932; 1840) description and illustration of the species. The largest specimen is here designated **lectotype** (BMNH 198032) (Figure *13*); the others, **paralectotypes** (BMNH 198033).

The type specimens of *Stenoplax histrio* Berry, 1945, (CAS 029871), *Ischnochiton mariposa* Dall, 1919, (USNM 58865), and *Chiton petaloides* Gould, 1946, (USNM 12922), previously examined, have been reported elsewhere (Smith, 1977; Smith & Ferreira, 1977).

Stenoplax Dall, 1879

Type Species: *Ischnochiton limaciformis* Sowerby, 1832, by OD.

Stenoplax corrugata (Carpenter *in* Pilsbry, 1892)
(Figure *14*)

Ischnochiton corrugatus Carpenter *in* Pilsbry, 1892b, **14**: 123-124—Dall, 1921: 192—Keep, 1904: 349—Oldroyd, 1927: 881—Palmer, 1945: 101

Ischnochiton (Stenoplax) corrugatus Carpenter *in* Pilsbry. Smith, 1947b: 18; 1947c: 7-8—Palmer, 1958: 271; plt. 29, figs. 5-8

Stenoplax corrugata (Carpenter *in* Pilsbry). Smith, 1963: 148—Burghardt & Burghardt, 1969: 35 (with syn. *S. biarcuata* (Dall, 1903))—Abbott, 1974: 396-397 (with syn. *Ischnochiton biarcuatus* Dall, 1903)

Ischnochiton biarcuatus Dall, 1903: 176—Lowe, 1904: 19

Ischnochiton (Stenoplax) biarcuatus Dall. Dall, 1921: 190—Oldroyd, 1927: 881—Smith, 1947a: 18; 1947b: 6

Stenoplax circumsenta Berry, 1956: 72—Ferreira, 1972: 55-56, figs. 1-2—Hanselman, 1973: 20-21; figs. 1-8—Poorman & Poorman, 1978: 373

Type Material and Type Locality:

Ischnochiton corrugatus Carpenter *in* Pilsbry, 1892: Holotype (Redpath Museum, No. 37); locality, "Catalina Is. 40fms." California [33°23′N; 118°24′W]

Ischnochiton biarcuatus Dall, 1903: Holotype (USNM 109308); locality, "Off Avalon [Santa Catalina Island, California], 50fms"

Stenoplax circumsenta Berry, 1956: Holotype (S. S. Berry colln., No. 13602) and paratype (S. S. Berry colln. 13627); locality, Isla Concha, Scammons Lagoon, Baja California, Mexico [27°50′N; 114°20′W]

Material Examined: CLARION: 1 specimen, off Sulphur Bay (18°19′05″N; 114°45′25″W), 57 fathoms [107m], January 5, 1934 (LACM-AHF 137-34)

Description: The single specimen (Figure *14*) dry, curled, estimated length (if extended flat) 6mm, width 2.5mm, is uniformly salmon red. Tegmentum mostly smooth, somewhat shiny. Lateral areas of intermediate valves moderately elevated, with 4-6 concentric corrugations better defined towards periphery. Anterior valve and postmucro area of posterior valve with similar sculpture. Central areas smooth. Posterior valve rather depressed; mucro central, postmucro slightly concave. Articulamentum white; sinus wide; slits 8-1-9. Girdle's upper surface, in same color as tegmentum, covered with minute, ca. 110 $\times$ 70μm, translucent, imbricated scales with 6-8 strong ribs defining equally wide striations; marginal fringe of spicules, about 150 $\times$ 25μm, with longitudinal striations; undersurface juxtaposed, transparent, rectangular scales, ca. 70 $\times$ 30μm, featureless otherwise; girdle bridges (see Ferreira, 1983), empty. Radula 2.0mm long, comprising 45 rows of mature teeth; median teeth elongate, incurved sides, blade at anterior end; first lateral teeth wider, in-

curved outer edge with knob at anterior-outer corner; heads of major lateral tooth, bicuspid; outer marginal teeth, elongate, length/width = 1.5.

In every respect, the specimen exhibits the characteristics of a juvenile of *Stenoplax corrugata.*

Distribution: *Stenoplax corrugata,* as here understood, is found both, on the Pacific side of Baja California, and in the Gulf of California. In the Pacific it ranges from Santa Cruz Id., California (34°01′N; 119°45′W) (AJF colln., *leg.* December 1970, at 17m) to Magdalena Bay (24°40′N; 112°00′W) (LACM 71-14), having been collected, also, at San Pedro, Los Angeles Co. (LACM 75-111), Santa Barbara Id, (AJF 243), Santa Catalina Id. (AJF colln., *leg.* November 1971), Coronados Is. (AJF 96), Punta Banda (LACM 67-53), Todos Santos Bay (CAS 029670; AJF 91), Sacramento Reef (AJF 94), San Martin Id. (AJF 95), Guadalupe Id. (LACM-AHF 1919-49; CAS 029668; CAS 029669) and San Pablo Pt. (LACM 71-178). In the Gulf of California, it has been collected at Pichilingue, La Paz, Baja California (AJF colln., *leg.* July 1971), Espiritu Santo Id. (AJF colln., *leg.* October 1970), Partida Id. (AJF colln., *leg.* September 1971), Danzante Id. (AJF 124, *leg.* E. Janss, Ann Howell, & A. J. Ferreira, aboard M/V *Disappearance,* 25 November 1973), north end of Monserrate Id. (25°43′N; 111°03′W) (AJF 628, aboard R/V *Baja Explorador,* 27 October 1981), and Medio Id., off Guaymas, Sonora, Mexico (27°55′N; 111° 58′W) (Hanselman, 1973).

Bathymetric range, 3-103m.

Remarks: A specimen of *Ischnochiton corrugatus* (CAS 029-670 [formerly CASG 2854]), from Todos Santos Bay, Baja California, Mexico, collected by H. Hemphill [Loc. 4041 (H. H.)], considered by S. S. Berry, in a hand-written note, to have "practically the significance of a type," preserved dry, soft parts removed, uniform salmon color, 18mm long, agrees with the current interpretation of the species.

The conspecificity of *Stenoplax corrugata* and *S. circumsenta* had not been previously recognized. The two species were assumed to differ in the upward-pointing, sharply triangular, spinelet-like girdle scales, conspicuously present in *S. circumsenta,* absent in *S. corrugata.* Comparing the two species, Berry (1956: 72) stated, "In sculpture this species [*Stenoplax circumsenta*] somewhat approaches *S. corrugata* (Carpenter). It sharply differs from that species, however, as from every other known *Stenoplax,* in the curious acute spines of the girdle."

However, several observations have led to the conclusion of conspecificity:

1) The number and distribution of triangular spinelets in *Stenoplax circumsenta* is extremely variable from specimen to specimen, making for gradients between the appearance of the girdle of "typical" *S. corrugata* and *S. circumsenta.*

2) Specimens of *S. circumsenta* have been found at Santa Barbara Id., Channel Is., California, (AJF 243), practically at the type locality of *S. corrugata.*

3) Comparison of specimens referrable to either species on the basis of the girdle elements showed them in every other respect—shape, size, color, tegmental sculpture, articulamental features, and radula—identical.

4) Aside from the triangular spinelets, the other girdle scales of *S. circumsenta* are indistinguishable from those of *S. corrugata.*

5) Examination of a lot of 8 specimens of *S. circumsenta* from Magdalena Bay (LACM 71-14) revealed that the number and size of triangular spinelets in the girdle is, to some extent, a function of the size (age) of the specimen: the larger two specimens, 24 and 22mm long show abundant spinelets; smaller specimens, 16 to 12mm long, display only occasional ones; the smallest specimen, 11mm long, shows none.

From these observations it is clear that the appearance of the large, triangular spinelets in *Stenoplax "circumsenta"* is a secondary phenomenon, the outgrowing of the girdle scales of *S. corrugata.*

Lepidozona Pilsbry, 1892b

Type Species: *Chiton mertensii* Middendorff, 1847, by OD.

Lepidozona clarionensis Ferreira, spec. nov.
(Figures *15, 16,* 17, 18)

Diagnosis: Small chitons (up to 1.5cm long), high-arched, carinate; valves' posterior edges straight, not beaked, but serrate. Color variable with rose and cream tones predominating, often variegated. Radial granose ribs in anterior valve (15-20, often bifurcating), postmucro area of posterior valve (10-12, poorly defined), and lateral areas of intermediate valves (mostly 2, or bifurcating into 3-4). Central areas with longitudinal, mostly parallel, latticed ribs, extending onto jugum forming no wedge figure. Girdle scales oval, moderately convex, ribbed to form 12-15 well defined striae. Radula's major lateral teeth, bicuspid.

Description: **Holotype** (Figure *15*) fully extended, preserved in alcohol, 14.3mm long, 8.5mm wide, 2.0mm high. Width/length ratio, 0.59. Jugal angle about 105°. Carinate; posterior edge of valves straight, not beaked. Gills holobranchial, abanal, 22 plumes per side extending about 90% of foot length.

Tegmental surface microgranular, predominantly cream color with dark grayish brown blotches at periphery. An-

terior valve with 15 granose radial ribs, tending to bifurcate at periphery; posterior edge serrate due to some 10 tubercles protruding at suture; tegmental surface 2.0mm long, 4.6mm wide, length/width ratio 0.43. Lateral areas of intermediate valves well defined, moderately elevated, with 2 (bifurcating to 4) similar radial ribs; posterior edge serrate due to protruding tubercles at sutures. Central areas with about 15 longitudinal riblets, neatly latticed, mostly parallel and extending onto jugum. Posterior valve somewhat depressed; mucro central; postmucro with some 12, poorly defined, granose radial ribs; postmucro slightly concave; tegmental surface 2.8mm long, 4.4mm wide, length/width ratio 0.64. Widths of valves i/viii, ratio 1.05.

Articulamentum white. Sutural laminae semi-oval; sinus well defined, relatively wide. On valve viii, width of sinus / width of sutural laminae = 1.0mm / 2.1mm = 0.5. Insertion teeth sharp, well defined; slits, 11-1-11, followed by slit rays. Eaves solid.

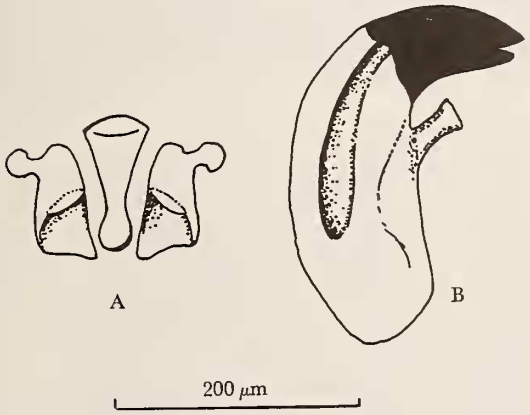

Figure 17

Lepidozona clarionensis Ferreira, spec. nov. **Holotype**, CAS 030662. Radula: A) Median and first lateral teeth, B) Major lateral tooth

Girdle cream with dark blotches; maximum width at valve iv, 1.4mm. Upper surface covered with oval, translucent, imbricated scales, largest 160μm long, with 12-15 ribs defining that many striae of about equal width. Girdle bridges (see FERREIRA, 1983), empty. Undersurface paved with imbricated, transparent, rectangular scales, about 80 × 15μm (Figure 18).

Radula 3.4mm long (24% of specimen's length), comprising some 35 rows of mature teeth. Median tooth about 100μm long, 85μm wide at anterior blade, narrowing posteriorly to 15μm but enlarging again to about 30μm at

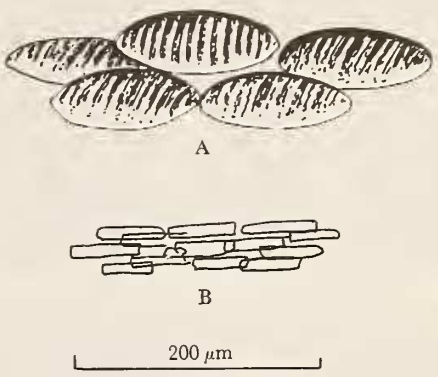

Figure 18

Lepidozona clarionensis Ferreira, spec. nov. **Holotype**, CAS 030662. Girdle: A) Scales of dorsal surface, B) Scales of ventral surface

posterior end. First lateral teeth about 100μm long, 60 μm wide, rectangular, with conspicuous round knob, 20μm in diameter, at outer-anterior corner. Major lateral teeth about 270μm long, with bicuspid head, and large knob at inner edge (Figure 17). Spatulate teeth with simple, round spatula, 85μm wide. Outer-marginal teeth about 100μm long, 80μm wide, width/length ratio 1.2.

Type Material: **Holotype** (disarticulated valves and girdle; mounted fragments of radula and girdle scales) (CAS 030662); the specimen is the largest of 4 specimens collected by J. Hewitt & A. J. Ferreira with SCUBA on the southeast side of Clarion, near Roca Piramide, at 15m, 26 November 1981 (AJF 640). All 25 other specimens of *Lepidozona clarionensis* collected at Clarion in the course of the same expedition of November 1981 are here designated **paratypes** (CAS 030663; LACM 1821; ANSP A9449; USNM 792398; AJF private colln.). They were collected by J. Hewitt & A. J. Ferreira as follows: 3 specimens (in addition to holotype), 6.5 to 14.3mm long, near Roca Partida, at 15m, 26 November 1981 (AJF 640); 4 specimens, 6.2 to 12.4mm long, east entrance of Sulphur Bay, at 10m, 26 November 1981 (AJF 641); 1 specimen, 11.5mm long, Monument Rock, on northwest corner of the island, at 17-20m, 27 November 1981 (AJF 643) (Figure *16*); 2 specimens, 11.3 and 15.3mm long, unnamed cove on south side of the island, at 17m, 27 November 1981 (AJF 645); 5 specimens, 10.0 to 14.7mm long, east end of the island, at 13m, 28 November 1981 (AJF 646); 6 specimens, 11.0 to 15.0mm long, west entrance of Sulphur Bay, at 20m, 28 November 1981 (AJF 647); 4 specimens, 10.0 to 13.7mm long, southwest side of the island, at 25m, 28 November 1981 (AJF 648).

Type Locality: Clarion Island, Revillagigedo Archipelago, Mexico (18°22′N; 114°44′W).

Other Material: CLARION: Sulphur Bay, 5 January 1934 (LACM-AHF 134-34), 3 specimens, 6.5 to 9.5mm long. SOCORRO: Braithwaite Bay, at 8-10m, 4 November 1979 (AJF 494), 3 specimens 8.0 to 12.5mm long; Punta Pinaculo, Caleta Grayson, at 10-17m, 5 November 1979 (AJF 496), 1 specimen, 14.1mm long; Cabo Henslow, at 25m, 6 November 1979 (AJF 498), 1 specimen, 13.0mm long; Islotes Rocosos, at 13m, 7 November, 1979 (AJF 506), 1 specimen, 17.0mm long.

Distribution: *Lepidozona clarionensis* seems to be endemic to the Revillagigedos Islands, having been collected only at Clarion and Socorro. Bathymetric range, 8-25m.

Remarks: Except in color, specimens of *Lepidozona clarionensis* do not show much intraspecific variation; Socorro specimens do not differ from Clarion specimens. Largest specimen, 17.0mm long, 10.0mm wide (AJF 506, Islas Rocosas, Socorro, *leg.* Gwen Cornfield at 13m). Body width/length ratio, mean = 0.59 (s.d. = 0.03; n = 32).

Lepidozona clarionensis is rather similar to *L. sinudentata* (Carpenter *in* Pilsbry, 1982) with which it was initially confused. Although there are subtle differences in tegmental sculpture between the two species, reliable differentiating characters were found only upon microscopic examination of the girdle scales (160μm long, with 12-16 striae in *L. clarionensis;* 200μm long, with 10 striae in *L. sinudentata*) and the radula (major lateral teeth head, bicuspid in *L. clarionensis;* unicuspid in *L. sinudentata*). Likely, the two species are phylogenetically close.

The species is here named *clarionensis* after Clarion Island, its type locality.

Lepidozona rothi Ferreira, spec. nov.
(Figure *19, 20,* 21, 22)

Diagnosis: Chitons small (up to 1.5cm long), high-arched, carinate. Valves' posterior edge straight, not beaked, not serrate. Anterior valve with 30-35 radial ribs cut into granules by some 10 concentric grooves; similar sculpture on lateral areas (4-6 radial ribs), and postmucro area (about 20 radial ribs, poorly defined). Central areas with longitudinal, latticed riblets extending onto jugum and forming wedge figure on jugal area of second valve. Girdle scales moderately convex, 200μm long, with obsolete striation, mammillate. Radula's major lateral teeth, unicuspid.

Description: **Holotype** (Figures *19, 20*) fully extended, preserved in alcohol, 12.5mm long, 8.0mm wide, 2.3mm high. Width/length ratio, 0.64. Jugal angle about 110°. Carinate; posterior edge of valves straight, not beaked or serrate. Gills holobranchial, abanal, 23 plumes per side, extending 100% of foot's length.

Tegmental surface microgranular, light cream color. Anterior valve with 35 radial ribs cut into some 10 granules by concentric grooves; posterior edge relatively smooth, not serrate; valve 2.2mm long, 5.5mm wide, length/width ratio 0.6. Lateral areas of intermediate valves well defined, moderately elevated, with 4-6 similar radial ribs, posterior edges relatively smooth. Central areas with about 24 longitudinal riblets, neatly latticed, parallel and extending onto jugum; on valve ii jugal riblets diverge forward forming wedge-like figure. Posterior valve 2.7mm long, 4.5mm wide, length/width ratio 0.6; mucro slightly anterior; postmucro area slightly concave, with some 20 granose, ill-defined radial ribs. Widths of valves i/viii, ratio 1.22.

Articulamentum white, dull. Sutural laminae semi-oval; sinus well defined, relatively wide. On valve viii, width of sinus / width of sutural lamina = 1.0mm / 2.1mm = 0.5. Insertion teeth well defined, thick, blunt; slits 10-1-10, without slit-rays. Eaves solid.

Girdle light cream color; maximum width at valve iv, 1.5mm. Upper surface covered with oval, imbricated scales, largest 200μm long, with some 12 obsolete striations, some bearing nipple-like protrusion 20-25μm high, 60-80 μm long, vaguely striated. Girdle bridges, empty. Undersurface paved with imbricated, transparent, rectangular scales, about 75 × μm (Figure 22).

Explanation of Figures *14* to *16, 19, 20, 23* to *25*

Figure *14: Stenoplax corrugata* (Carpenter *in* Pilsbry, 1892). Specimen 6mm long (? juvenile). Anterior, 2 intermediate, and posterior valves

Figure *15: Lepidozona clarionensis* Ferreira, spec. nov. **Holotype** (CAS 030662). Anterior, intermediate, and posterior valves

Figure *16: Lepidozona clarionensis* Ferreira, spec. nov. **Paratype,** 10mm long (AJF 643) (CAS 030663). Side view of lateral areas

Figure *19: Lepidozona rothi* Ferreira, spec. nov. **Holotype** (LACM 1818). First, second, fourth, and eight valves

Figure *20:* Same as in Fig. *19.* Close-up of lateral and pleural areas of fifth valve

Figure *23: Chaetopleura scabricula* (Sowerby, 1832). Specimen 20mm long (AJF 496, Socorro Id., Revillagigedos, Mexico). Close-up of anterior valves

Figure *24: Chiton articulatus* Sowerby, 1832. Specimen 65mm long (AJF 500, Socorro Id., Revillagigedos, Mexico)

Figure *25:* Same as in Fig. *24.* Close-up of intermediate valves

Figure 14

Figure 15

Figure 16

Figure 19

Figure 20

Figure 23

Figure 24

Figure 25

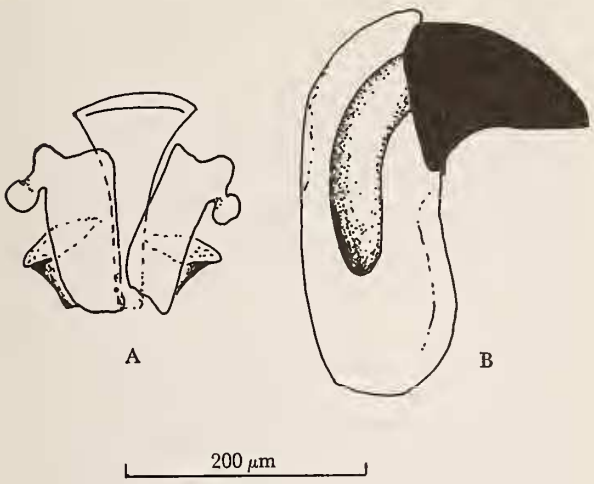

Figure 21

Lepidozona rothi Ferreira, spec. nov. Holotype, LACM 1818. Radula: A) Median and first lateral teeth, B) Major lateral tooth

Radula 5.0mm long (40% of specimen's length), comprising 26 rows of mature teeth. Median tooth 100μm wide at anterior blade narrow posteriorly to 50μm. First lateral teeth about 150μm long, 60μm wide, rectangular, with round knob, 22μm in diameter, at outer-anterior corner. Major lateral teeth 300μm long, with robust, unicuspid head, about 120μm long, 100μm of maximum width (Figure 21). Spatulate teeth with simple, round spatula, 80μm wide. Outer-marginal teeth 140μm long, 90μm wide, length/width ratio 1.6.

Type Material: **Holotype** (disarticulated valves and girdle; mounted fragments of radula and girdle scales) (LACM 1818). It was collected off Sulphur Bay, Clarion Island, Revillagigedos, Mexico, at 40-50 fathoms [82-91m] during an expedition of the Allan Hancock Foundation, 16 March 1939 (LACM-AHF 918b-39).

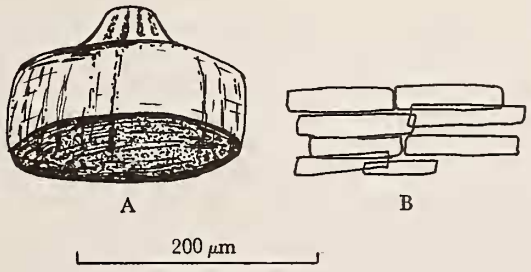

Figure 22

Lepidozona rothi Ferreira, spec. nov. Holotype, LACM 1818. Girdle: A) Scale of dorsal surface, B) Scales of ventral surface

Type Locality: Off Sulphur Bay, Clarion Island, Revillagigedos, Mexico (18°19'45" N; 114°44'35" W), at 82-91m.

Other Material: COCOS ISLAND, Costa Rica: Chatham Bay (5° 33'50" N; 86°59'50" W), at 40-60 fathoms [70-110m], 14 January 1938 (LACM-AHF 780a-38), 4 specimens, about 10mm to 12mm long; off Nuez Island (5°34'00" N; 86°59'20" W), at 30-50 fathoms [55-90m], 14 January 1938 (LACM-AHF 779-38), 1 specimen, 11mm long.

Distribution: *Lepidozona rothi* is known only from Clarion Id., Mexico, and Cocos Id., Costa Rica, from 55-110m.

Remarks: In general appearance, *Lepidozona rothi* is similar to *L. clarionensis* and *L. sinudentata.* It differs from *L. clarionensis* mainly in its 1) relatively wider body, 2) more numerous radial ribs on end valves and lateral areas, 3) more numerous riblets on central areas, 4) larger and mammillated girdle scales, and 5) unicuspid radula's major lateral teeth. It differs from *L. sinudentata* in its 1) relatively wider body, 2) more numerous radial ribs on end valves, 3) more numerous riblets on central areas, 4) smaller and mammillated girdle scales.

The species is here named **rothi** after Dr. Barry Roth, Department of Invertebrate Zoology, California Academy of Sciences, who, ever patiently, has given much of his time and knowledge to guide and enrich my research efforts.

Chaetopleuridae Plate, 1899

Chaetopleura Shuttleworth, 1853

Type Species: *Chiton peruvianus* Lamarck, 1819, by SD (Dall, 1879).

Chaetopleura scabricula (Sowerby, 1832) (Figures 6, *23*)

Chiton scabriculus Sowerby (1st) *in* Broderip & Sowerby, 1832: 28—Sowerby (1st and 2nd), 1840: 8, no. 100, fig. 21—Reeve, 1847, plt. 15, sp. & Fig. 81—Pilsbry, 1892a, 14: 33 (as syn. of *Chaetopleura lurida* (Sowerby, 1832))—Keen, 1958: 524 (as syn. of *C. lurida)*—Thorpe *in* Keen, 1971: 877 (as syn. of *C. lurida*).

Chaetopleura scabricula (Sowerby). Ferreira, 1983

"*Chaetopleura lurida* (Sowerby)" *ex auttore* treating Panamic species. Pilsbry, 1892a, 14: 33-35, plt. 12, figs. 53-54—Steinbeck & Ricketts, 1941: 552, plt. 12, figs. 53-54 [reprinted, 1971]—Keen, 1958: 524, Amphineura, fig. 35—

Thorpe *in* Keen, 1971: 877-878, Polyplacophora, fig. 41—Abbott, 1974: 401—Smith, 1977: 217, 243, 246. [not *Chiton luridus* Sowerby, 1832, a *nomen dubium*]

"*Chiton columbiensis* Sowerby, 1832." Pilsbry, 1892a, 14: 34-35, plt. 12, figs. 51-52 (as var. of *C. lurida*)—Thorpe *in* Keen, 1971: 877 (as syn. of *C. lurida*). [not *Chiton columbiensis* Sowerby, 1832, a *nomen dubium*]

"*Chiton catenulatus* Sowerby, 1832." Thorpe *in* Keen, 1971: 877 (as syn. of *lurida*). [not *Chiton catenulatus* Sowerby, 1832]

"*Chiton jaspideus* Gould, 1846." Thorpe *in* Keen, 1971: 877 (as syn. of *C. lurida*)—Abbott, 1974: 401 (as syn. of *C. lurida*). [not *Chiton jaspideus* Gould, 1846 (= *Chaetopleura hennahi* (Gray, 1828))]

Lepidopleurus bullatus Carpenter, 1857a: 252 *nomen nudum;* 1857b: 195-196—Brann, 1966: 45, fig. 254—Keen, 1968: 434, plt. 59, fig. 95—Thorpe *in* Keen, 1971: 877 (as syn. of *C. lurida*)—Smith, 1977: 217, 243 (as syn. of *C. lurida*)

Lepidopleurus bullatus calciferus Carpenter, 1857a: 252, *nomen nudum;* 1857b: 196—Brann, 1966: 45, fig. 245b—Keen, 1968: 434, plt. 59, fig. 96—Thorpe *in* Keen, 1971: 877 (as syn. of *C. lurida*)—Smith, 1977: 217, 243 (as syn. of *C. lurida*)

Chaetopleura bullata (Carpenter). Pilsbry, 1892a, 14: 31-32—Keen, 1958: 524, Amphineura, figs. 33, 33a

Chaetopleura bullata calcifera (Carpenter). Pilsbry, 1892a, 14: 32—Keen, 1958: 524, Amphineura, fig. 33, 33a

Ischnochiton parallelus Carpenter, 1864a: 314 (reprinted, 1872: 213); 1864b: 618 (reprinted, 1872: 104)—Keen, 1958: 524 (as syn. of *C. lurida*)—Thorpe *in* Keen, 1971: 877 (as syn. of *C. lurida*)—Smith, 1977: 217, 246 (as syn. of *C. lurida*)

Chaetopleura lurida var. *parallela* (Carpenter *in* Pilsbry, 1892a, 14: 34, plt. 12, fig. 50

Chaetopleura parallela (Carpenter). Dall, 1921: 193—Oldroyd, 1927: 889-890—Smith, 1947a: 18; 1947b: 4—Palmer, 1945: 100; 1958: 267—Abbott, 1974: 401 *("lurida ?")*

Ischnochiton prasinatus Carpenter, 1864a: 315 (reprinted, 1872: 213); 1864b: 618 (reprinted, 1872: 104)—Keen, 1958: 524 (as syn. of *C. lurida)*—Thorpe *in* Keen, 1971: 877 (as syn. of *C. lurida*)—Smith, 1977: 217, 246 (as syn. of *C. lurida*)

Chaetopleura lurida var. *prasinata* (Carpenter). Pilsbry, 1892a, 14: 34

Chaetopleura prasinata (Carpenter). Dall, 1921: 193—Oldroyd, 1927: 889—Burch, 1942: 7—Smith, 1947a: 18; 1947b: 4-5—Palmer, 1958: 267—Abbott, 1974: 407 *("lurida ?")*

Choetopleura [sic] *dacrydigera* Rochebrune, 1882: 193

Type Material and Type Locality:

Chiton scabriculus Sowerby, 1832: Lectotype (BMNH 1980113) and paralectotypes (BMNH 1980114); locality, Puerto Portrero, Costa Rica (10°28′ N; 85°47′ W) (Ferreira, 1983)

Material Examined: SAN BENEDICTO: Punta Ortolan, at 18m (AJF 508), 1 specimen, *leg.* G. Corsi. SOCORRO: (ANSP 72501), 1 specimen, 15.5mm long, *leg.* R. C. McGregor [cited in Pilsbry, 1898: 51]; S end, at 2-7m, 14 February 1971 (LACM 71-26), 1 specimen, 8mm long, *leg.* C. Swift aboard R/V *Searcher*; Punta Pinaculo, Caleta Grayson, at 9-15m, 5 November 1979 (AJF 496), 26 specimens, 8-28mm long; Caleta Binmer, at 0-1m, 5 November 1979 (AJF 497), 1 specimen, 15mm long; Cabo Middleton, E side of Academy Bay, at 8-25m, 7 November 1979 (AJF 503), 2 specimens, 10.5 and 16mm long; N side of Academy Bay, at 8m (AJF 504), 3 specimens, 15-18mm long.

Description: The examined 36 specimens of *Chaetopleura scabricula* from Socorro and San Benedicto, 8-28mm long, are mostly tan to brown, often with wide, darker, parajugal bands and zebra-like pattern of brown/cream lines on lateral areas. Body width/length, mean 0.62 (s.d. = 0.04; n = 15). Tegmentum pustulose; on end valves and lateral areas of intermediate valves, large pustules (up to 100μm in height and diameter) rise against smooth, almost shiny surface background; on central areas, much smaller pustules (about 20μm in height, 30μm in diameter) often coalesced into 15-20 riblets per side, and extending onto jugum; on valve ii, subdued jugal tract of longitudinal riblets diverges out forward outlining wedge-like figure (Figure *23*). Mucro slightly anterior; postmucro straight to concave. Articulamentum white. Insertion teeth sharp; slits, 9-1-9, followed by slit-rays. Sutural laminae subtriangular to subrectangular. Girdle's upper surface with chaffy scales, about 25 × 10μm, and abundant, large (up to 1.5mm long), simple, golden-brown hairs; bridges, outer ¼ with crowded, transparent, slender spicules, 100 × 15μm, but with no spicules or other elements in middle ½; undersurface covered with transparent, rectangular scales, about 35 × 20μm, with convex outer edge and concave inner edge. Radula with rectangular, wide median tooth, and tricuspid major lateral teeth.

Compared to mainland specimens of *Chaetopleura scabricula,* Revillagigedos specimens are indistinguishable in size, body proportions, girdle elements, articulamentum, and radula. They are, however, phenotypically distinct in their subdued tegmental sculpture. Most Revillagigedos specimens show only occasional pustules on end valves and lateral areas, a characteristic which, together with subdued riblets on central areas, confers upon them a rather smooth appearance sharply different from the scabrous one of mainland specimens. These differences in tegmental sculpture are particularly evident in larger (older) specimens.

Distribution: *Chaetopleura scabricula* ranges from Bahía de San Francisquito, Baja California, Mexico (28°26′ N; 112° 53′ W) (CAS 030249), the central part of the Gulf of California, to Gorgona Id., Colombia (2°58′ N; 78°11′ W) (LACM-AHF 405-35). Bathymetric range, 0-30m.

Remarks: Although, in time, histological, biochemical, electrophoretic, or other studies may prove otherwise, morphological observations alone indicate that the Revillagigedos population of *Chaetopleura* is conspecific with the mainland populations of *Chaetopleura scabricula* (Sowerby, 1832). The phenotypical distinctions noted above do not seem sufficient to separate the two populations taxonomically at the species level. Unquestionably, some workers would regard the Revillagigedos population of *Chaetopleura* as distinct enough to receive subspecies status.